PTO 05-300

Chinese Patent

CN 1368518A

RUBBER COMPOSITE MATERIAL FOR UNDER-RAIL CUSHION

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UNITED STATES PATENT AND TRADEMARK OFFICE

Washington, D. C. October 2004

Translated by: Schreiber Translations, Inc.

Country	:	People's Republic of China
Document No.	:	1,368,518
Document Type	:	Patent
Language	:	Chinese
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Applicant	:	Chengdu Rentai Industrial Co. Ltd.
IPC	:	C08K 3/08
Application Date	:	March 8, 2002
Publication Date	:	September 11, 2002
Foreign Language Title	:	Guixia Jiaodian Xiangjiao Fuhe Cailiao Zuhewu
English Title	:	RUBBER COMPOSITE MATERIAL FOR UNDER-RAIL CUSHION

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[57] Abstract

This invention concerns a rubber composite material for under-rail cushion, the components of which include 100 shares of base material, 1~5 shares of accelerant, 1~3 shares of anti-aging agent, 2~10 shares of nanometer zinc oxide powder, 0.2~1.5 shares of curing agent, 30~60 shares of carbon black, 30~60 shares of inorganic filler, 0.5~10 shares of four-needle-shaped zinc oxide whisker, and 0.2~5 shares of coupling agent. The base material consists of natural rubber, butadiene styrene rubber, and polybutadiene rubber. The static rigidity of under-rail cushion made from the above material is 50~70MN/m. The tensile strength is enhanced by 10~30%. The strength dropdown after aging is reduced by 15~40%. The abradability is enhanced by 15~50%. The vibration attenuation coefficient is enhanced by 20~50%. The noise reduction effectiveness is enhanced by 5~20%. The rubber composite material is mainly used for anti-vibration under-rail cushion in express railways, speed-enhanced railways, and common railways. It can also be used as other rubber anti-vibration product.

[1] Numbers in the margin indicate pagination in the foreign text.

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Claims

This invention involves in:

1. A rubber composite material for under-rail cushion, the components of which include base material, accelerant, anti-aging agent, curing agent, carbon black, inorganic filler, coupling agent, four-needle-shaped zinc oxide whisker, as well as nanometer zinc oxide powder. The weight proportions of the components are 100 shares of base material, 1~5 shares of accelerant, 1~3 shares of anti-aging agent, 2~10 shares of nanometer zinc oxide powder, 0.2~1.5 shares of curing agent, 30~60 shares of carbon black, 30~60 shares of inorganic filler, 0.5~10 shares of four-needle-shaped zinc oxide whisker, and 0.2~5 shares of coupling agent. The base material consists of natural rubber, butadiene styrene rubber, and polybutadiene rubber in the weight proportion of 40~80 shares of natural rubber, 10~30 shares of butadiene styrene rubber, and 10~30 shares of polybutadiene rubber.

2. A rubber composite material for under-rail cushion as described in Claim 1, whereas the four-needle-shaped zinc oxide whisker must be undergone surface treatment with coupling agent.

3. A rubber composite material for under-rail cushion as described in Claim 1, whereas the inorganic filler can be China clay, white carbon black, calcium carbonate, or their mixtures.

Instruction

Rubber Composite Material for Under-rail Cushion

Technical Field

This invention concerns a composite material, especially a rubber composite material for under-rail cushion.

Background Technology

One of the glaring problems existed in today's railway rails is the excessively high rail rigidity and insufficiency in rail elasticity. This problem causes vibration of the wheel track system and increasingly high noise, resulting in early-stage damage of rails, shortened component life, worsened rail quality, and highly increased maintenance cost. In the meantime, the vibration also does harm to facilities sensitive to vibration nearby the railway lines, does harm to the environment, and impedes the train speed enhancement and express railway development. In order to well solve this problem, domestic and abroad railway experts consider that it is necessary to take measures to reduce rail rigidity and improve rail elasticity. The measure commonly taken is to place elastic rubber cushion under rail. The perpendicular elasticity of concrete cross tie rail is

provided mainly by under-rail rubber cushions. The performance of under-rail rubber cushion as an important component of steel rail fastener not only determines the reliability of the operation of steel rail fastener, but also determines the train running smoothness and dominates the economy of railway maintenance. The main problems existed in model 60-10-11 under-rail rubber cushions for concrete cross ties broadly applied currently are excessively high rigidity (which is generally 100~120MN/m), fast aging process (the rigidity after use of several months is generally 150~200MN/m), poor abradability and pressure resistance property, short lifetime (the average lifetime is less than 5 years). These weaknesses have restricted the elaboration of buffering and vibration reduction of the cushions in the rail structure. The approach of using multi-groove cushions can lower the rigidity but will accelerate the aging and damage of rubber cushions. The Chinese patent CN1230565 disclosed a rubber-based composite material, in which three-dimensional four-needle-shaped zinc oxide whiskers are added in the traditional rubber formula. In this composite material, the contents of each component are 60~90% raw rubber, 0.1~1.0% accelerant, 0.5~1.5% anti-aging agent, 2~10% zinc oxide powder, 2~10% sulfur, and 1~30% zinc oxide whisker. This composite material is mainly used for

preparation of abrasive and antiskid rubber products such as automobile tires and braking materials.

Content of Invention

The main objective of this invention is to provide a rubber composite material for under-rail cushion featuring greatly enhanced material dynamics properties, anti-aging property, abradability, and vibration and noise reduction.

In the rubber composite material for under-rail cushion in this invention, the components calculated in weight include 100 shares of base material, 1~5 shares of accelerant, 1~3 shares of anti-aging agent, 2~10 shares of nanometer zinc oxide powder, 0.2~1.5 shares

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of curing agent, 30~60 shares of carbon black, 30~60 shares of inorganic filler, 0.5~10 shares of four-needle-shaped zinc oxide whisker, and 0.2~5 shares of coupling agent. The base material consists of natural rubber, butadiene styrene rubber, and polybutadiene rubber in the weight proportion of 40~80 shares of natural rubber, 10~30 shares of butadiene styrene rubber, and 10~30 shares of polybutadiene rubber. The accelerants are those commonly used for rubber such as CZ, NOBS, and Accelerant M. The anti-aging agents are those commonly used for rubber such as Anti-aging Agent

A, Anti-aging Agent B, F-4010, Anti-vibration 4010-NA. The curing agent can be sulfur or benzoic acid peroxide. The inorganic filler can be China clay, white carbon black, calcium carbonate, or their mixtures. The four-needle-shaped zinc oxide whisker must be prepared according to the process described in Chinese Patent ZL97107607.3. The whisker has a special three-dimensional four-needle-shaped structure. Each needle-shaped object has a length of 10~200μm and bottom diameter of 0.1~10μm. In the application, the whisker must be undergone surface treatment with coupling agent. During the treatment, 0.3~5% coupling agent of organic titanate such as NDZ-201, NDZ-101 acetone solution (or other solvent such as alcohol) is first used for surface treatment in order to improve system compatibility. Other types of coupling agents such as A-189, A-845-4, Si-69, KH-560, KH-590 silane coupling agents can also be used for surface treatment. The treatment can be done through pre-treatment process or mixed smelting of the coupling agent with components. However, the pre-treatment process has a better result. The nanometer zinc oxide powder is prepared following the following steps: Use zinc nitrate as the main raw material and carbamide as the precipitant. Allow chemical reaction of the two materials in 70~100°C water solution to obtain precursor. Roast the precursor at 200~400°C for 1~3 hours

to obtain nanometer zinc oxide powder. The nanometer zinc oxide powder are spherical particles with the average diameter of 20~40μm.

The rubber composite material for under-rail cushion provided by this invention is advantageous in that four-needle-shaped zinc oxide whiskers and nanometer zinc oxide powder are added in the rubber composite material and its formulas based on natural rubber, butadiene styrene rubber, and polybutadiene rubber. As a result, the static rigidity of the under-rail cushion board is kept at 50~70MN/m. Compared to the current under-rail cushion board, the new cushion provided in this invention is greatly improved in dynamic properties, anti-aging property, abradability, and vibration and noise reduction performance.

Implementations

Fig. 1 Electron microscope picture of zinc oxide whiskers

Fig. 2 Electron microscope picture of zinc oxide whiskers after surface treatment with coupling agent

Fig. 3 Electron microscope picture of nanometer zinc oxide

The composition of base rubber materials in Implementations 1~4 and Comparisons 1~3 is calculated based on weight proportion, which is 70 shares of natural rubber, 20 shares of butadiene styrene rubber, and 10 shares of polybutadiene rubber. Other formulas are also

calculated based on weight proportion, as shown in Table 1. The preparation steps are as follows: Use acetone as solvent to prepare coupling agent of organic titanate into 1% solution. Put zinc oxide whiskers in the solution and soak for 30 minutes. Take out the whiskers and dry up, and roast at 135±5°C for 40 minutes. Smelt natural rubber in a smelting machine until the Mooney viscosity is less than 60. Add by order butadiene styrene rubber, polybutadiene rubber, filler, and other assistant agents. Well mix the components and then add in pre-processed zinc oxide whiskers and nanometer zinc oxide powder. Smelt the mixture in rolling state to derive rubber composite material for under-rail cushion. Leave the produced material for 6 hours and then use a flat board curing machine to cure the rubber composite material at 145°C for 20 minutes to form rubber rail cross tie cushions. The tested specifications of the rubber composite material are shown in Table 1. /3

The preparation process of the materials in the comparison groups is identical to that of the implementations, except that no zinc oxide whiskers and nanometer zinc oxide powder are added in the formula. The specifications of the rubber composite material of the comparison group are shown in Table 1.

Table 1 Formula (in Weight Proportion) and Property of Rubber

Composite Material for Under-rail Cushion

		Implementation				Comparison		
		1	2	3	4	1	2	3
Formula	Raw Rubber	100	100	100	100	100	100	100
	Accelerant	NOBS 2.5	CZ 2.5	Acce.M 2.5	NOBS 2.5	NOBS 2.5	NOBS 2.5	NOBS 2.5
	Anti-aging Agent	4010 1.2	4010-NA 1.2	A-A 1.2	A-D 1.2	4010 1.2	4010 1.2	4010 1.2
	Zinc Oxide	NM ZnO 2	NM ZnO 3	NM ZnO 2	NM ZnO 2.5	Ord. ZnO 5	Ord. ZnO 14	Ord. ZnO 5
	Sulfur	1.3	1.3	1.3	1.3	1.3	1.3	3
	Carbon Black	45	42	41	39	45	41	60
	Inorganic Filler	China Clay 42	Calcium Carbonate 42	White Carbon Black 40	China Clay 39	China Clay 42	Calcium Carbonate 42	China Clay 60
	Zinc Oxide Whisker	3	6	9	12	0	0	0
	Coupling Agent	NDZ-201 0.2	Si-69 0.3	Si-69 0.5	KH-590 0.6			
Property	Hardness (Shore Hardness)	72	73	74	75	68	70	80
	Tensile Strength (MPa)	16.7	17.4	18.2	18.8	14.8	15.0	13.6
	Elongation at Break	405	398	387	372	412	385	278
	200% Fixed Tensile Strength (MPa)	9.6	9.7	9.9	10.6	9.2	9.3	10.2
	Compression Permanent Deformation (%)	25.4	25.2	25.6	25.8	28.4	28.6	28.8
	Akron Abrasion (cm^3/1.61km)	0.32	0.28	0.22	0.19	0.54	0.51	0.65
	Static Rigidity (MN/m)	52.5	56.5	58.2	62.5	47.3	47.8	118.0
	Strength Dropdown After 100°CX72h Aging	21.2	18.3	15.1	13.6	32.1	29.2	35.6
	Noise Reduction (Relative value)	1.05	1.09	1.13	1.18	1.00	1.01	0.88

	Vibration Attenuation Coefficient	0.28	0.31	0.35	0.42	0.23	0.24	0.18

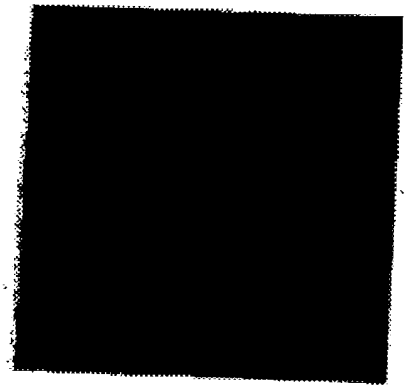

图 1

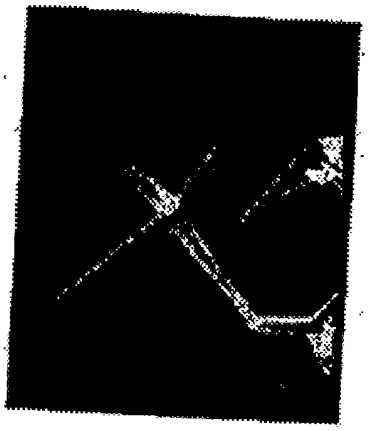

图 2

图 3